Subject Index

Aa lava flows 369f.
accessory phases in basalts 159
actinolite 37, 166
aegirine 5
aenigmatite 5
albite 33, 116, 166, 247
–, disorder kinetics 297f.
–, low 329
alkali basalts 161
alkali feldspar 4, 135, 268
–, exsolution 353ff.
alkalinity change with H_2O/SiC_2, kimberlite 227
allanite 159, 335
Al_2O_3, role in immiscible silicate liquids 319f.
alpine metamorphism 19
Al/Si disorder kinetics, albite 297f.
Al/Si ordering, alkali feldspar during metamorphism 363
aluminosilicates 319
amphibole 43ff., 341
–, geochronology, sub-ophiolites 50
– plagioclase, cation exchange equilibrium 33f.
–, REE concentrations 82
amphibolite 26, 46f., 341
– facies metamorphism 305
amygdales, pillow lavas 166
anatexis 58
ancylite 159
andalusite 319
andesites 387
andradite 232
anhydrite, Raman and i.r. spectra 201
anion partition between carbonates and solution 197f.
ankaramites 410
anorthite 33, 116
anorthosite 113, 311ff., 339f.
–, O-isotope data 313f.
anthophyllite 229
antigorite 229f.
– serpentinite 229f.
antiperthite 124
apatite 46, 159, 245, 335, 372
–, coexist. with sphene, REE partition 81f.
–, OH/(F,Cl) ion exchange 291f.
aphanitic flows 369
aragonite 197f.
assimilation 66f.
augen gneiss 283
augite 166, 341
–, exsolution 101ff.
–, –, cell dimensions of observed phases 102
awaruite 232

Baddeleyite 192
basaltic glass 428f.
basaltic magma, crystallization of accessory phases 158f.
basalts 2f., 46, 165f., 369, 387
–, oceanic ridge systems 425f.
–, –, petrogr. provinces 427f.
–, petrogenesis 170f.
batch melting, mantle 157f., 165, 399
benmoreite 2f.
biotite 4, 115, 124, 141, 159, 293, 353, 388
–, breakdown 283
–, fission tracks 335
–, O-isotopes 22f.
–, REE concentrations 82
block lava flows 369f.
blueschists, Turkey 243ff.
–, equilibrium conditions 251
–, fluid phase composition 251
–, phase relations 252
breakdown, biotite 283
–, Mg-chlorites 176f.
–, –, experimental results 178
brucite 231

Calc-alkaline basalts 168
calcite 166, 175, 247
–, travertine 197f.
calderas, Pinzon 368
carbonate, kimberlites 220
carbonatization, kimberlite magma 222f.
cation exchange equilibrium 24, 124f.
–, amphibole – plagioclase 33ff.
charnockite 111
–, Norway, O-isotopes 313f.
chemical analysis
–, ankaramites 410
–, apatite, Kangerdlugssuaq 82
–, basalts, Burin group 167
–, chlorites, blueschists 249
–, garnet amphibolites 46
–, –, amphiboles 48
–, –, pargasite 49
–, garnets, blueschists 249
–, glass, Lesbos volcanics 393
–, –, oceanic ridges 428
–, kimberlites, Yakutia 226
–, metapelites, osumilite-bearing 127
–, –, garnets 134
–, –, ilmenite 135
–, –, phlogopite 136
–, –, pyroxenes 132
–, –, sapphirine 127, 130
–, –, spinel 135
–, osumilite, Enderby 128
–, –, intergrowths 128
–, phengite, blueschists 249
–, phenocrysts, Pinzon lavas 373
–, –, clinopyroxenes 373
–, –, ilmenite 373
–, –, olivine 373
–, –, spinel 373
–, plagioclase amphibolites, Greece 46
–, sodic amphiboles, blueschists, Turkey 248
–, sphene, Kangerdlugssuaq 82
–, talc, blueschists 249
–, Ti-clinohumite 234, 416
–, tonalites, Scourie 274f.
–, travertine, Senami 198
–, troctolites, Hettasch 345
–, trondjemites, Scourie 274f.
–, ultrabasic magmas 349
–, volcanics, Banks Penins. 5–7
–, –, olivines 10
–, –, pyroxenes 11
–, –, titanomagnetite 12
–, volcanics, Lesbos 389
–, wadeites 193
chemical equilibrium 24
cherts 44, 243
chlorite 166, 230
–, blueschist 246
–, –, composition 250
–, fission tracks 335
– spinel paragenesis 175
chromite lherzolites 205
chrysotile 232
cinder cone 371
Cl, leucogabbro minerals 292
clastomylonitization 283
clinoamphibole in augite 105
clinohumite, Ti-~ 229f., 415f.
–, breakdown 233
–, formation 232
–, stability 237, 415f.
–, substitutions 230
clinopyroxene 4, 46, 102, 112, 124, 166, 181f., 230, 372, 388, 430
closing temperatures, fission track cooling rates 335
comb-layering, troctolite 341f.
compatible elements, basalt fractionation 405
contact metamorphism 229
–, Bergell aureole 232
cooling ages, U-Pb system 87
cordierite, stability 123f., 130f.
coronas, garnets 112ff., 116f.
–, reactions 116f.
Cr, influence on garnet stability in the mantle 212
crossite 245
crustal anatexis 58
crystal fractionation, basalt petrogenesis 15, 170f.
–, Lesbos shoshonites 394
crystal-liquid REE partitioning 145ff.
crystal-liquid relationships, model peridotite 188
crystal morphology, volcanics 339f.
cummingtonite 33, 229
cumulates, troctolite 346
cycles, volcanic, Pinzon 371f.

Dacite 372, 387
davidite 159
decarbonation reactions, peridotite 184
defect equilibria, natural garnets 152
depletion of elements in granulites 257ff.
–, K 258
–, mechanics 260
–, Rb 259
–, U and Th 262
D/H ratios, gneiss phases 22

diamond, inclusions 181ff.
– bearing kimberlites 219f.
diapirs, ascending mantle 165
differentiation, basalts 375f., 398f.
– series, validity of Rayleigh Law 407
diffusion, kimberlite-xenolith interactions 210
dikes s. dykes
diopside 175, 191, 230
disequilibrium 24
– melting 175f.
disordering kinetics, Al/Si in albites 297f.
–, effect of water 297f.
–, pressure influence 297f.
–, strain influence 297f.
dolomite 183
–, metamorphism 175f.
domes, Pinzon lava 370
dunite 341
dykes 5, 116, 370, 387
dynamic melting, upper mantle 165ff.

Eclogite 283
eclogitic suite, inclusions in diamonds 181f.
edenite 33
elemental depletion, granulites 257f.
enstatite 175, 229
epidote 46, 166, 335
–, blueschist 247f.
–, –, composition 250
equilibration pressure, xenoliths in kimberlites 205f., 213
– temperature, xenoliths in kimberlites 205f., 213
equilibrium, alkali feldspar exsolution 362f.
–, melting experiments 73ff.
–, O-isotopes 24f.
–, REE partition 146f., 157f.
– relations, amphibole and plagioclase 33f.
–, –, cation exchange diagrams 35
–, –, model 36
– temperatures, O-isotopes, Central Swiss Alps 27f.
Eu anomaly, Banks Penins. volcanics 7
exsolution, augite 101ff.
– processes, alkali feldspars 353ff.

F, leucogabbro minerals 292
feldspar composition, Banks Penins. volcanics 12
Fe-Mg partitioning, garnet/olivine 337
ferrobasalt 372
ferrogabbro 101
fission tracks, thermal annealing 335
flash melting 159f.
flow differentiation, pahoehoe 369
fluid phase, gneisses 21f.
flysch 44
forsterite 175, 237
foyaite 81
fractional crystallization 15, 257, 397f.
–, Lesbos shoshonites 392f.
–, Maladeta pluton 64
–, model for granulitic grade granitic suite 273f.
–, Pinzon lavas 380f.
–, –, models 381
–, trace element behaviour 399
fractional differentiation, mantle magma 220
fractional melting, mantle 157f., 165
fractionation models, Pinzon lavas 381

Gabbro 101, 167, 257, 266
gabbronorite 59f.
garnet 29, 46, 124, 134, 181, 283, 335
– amphibolites 46
–, blueschist 247f.
–, –, composition 250
–, formation in metaigneous rocks 111ff.
–, –, reactions 116f.
– lherzolite 205
– –, partial melting 170
– olivine geothermometer 337
– peridotite 410
–, REE substitution 147f.
–, stability in the mantle 212
geikielite 236, 420
geobarometry, xenoliths in kimberlites 207f.
geochronology, granitic gneiss, Glenfinnan 87ff.
–, Greek amphibolites 50f.
geodynamics, Variscan plutonics, Maladeta 69
geothermometry, xenoliths in kimberlites 205f.
glass, basaltic 428f.
–, volcanic 372, 392
glassy volcanics 425f.
glaucophane 33, 243f.
gneiss 124, 257f., 266f.
–, Lepontine 22f.
–, –, O-isotope equil. temperatures 29
–, U-Pb zircon data 87ff.
graded layering, troctolite 341
granite 57ff., 257, 268f., 283
–, perthite microstructures 353ff.
– system, metastable melting 73
– –, solidus temperatures 76
granitic gneiss, Glenfinnan, geochronology 87ff.
–, metamorphic history 90f.
granitic suite, granulite facies 266ff.
–, geochemistry 269f.
–, –, rare earth elements 272
–, silica variation diagrams 270
granodiorite 58, 268
granulite 124ff., 265ff.
– facies 257ff.
– genesis 303ff.
– –, melt composition 308
– grade metamorphism 305, 311
–, Hercynian, France, dating 283ff.
–, –, Rb/Sr data 285
–, –, U-Pb data 285
greenschist 26
– facies 230
gypsum, Raman and i.r. spectra 201

Harzburgite 205
hawaiite 2f.
heat and mass transfer, kimberlite-xenolith interactions 208
heating experiments, exsolved phases in augite 105
hematite 247
high-pressure granulites 258
H-isotope composition, biotites 22, 25
Henry's law, REE substitution in garnets, limits 148f.
hornblende 46, 115, 159, 267, 335, 353, 388
– plagioclase, cation exchange equilibria 33f.
humite 230, 415f.
hypersolvus granite, alkali feldspar exsolution 353f.
hypersthene – sillimanite 124ff., 131

Icelandites 369
ignimbrites, Lesbos 387f.
–, geochemistry 391f.
–, magma evolution 392
ilmenite 13, 112, 135, 230, 236, 372, 420
–, Norway, O-isotope data 313
immiscible silicate melts 319ff.
inclusions in diamonds 181f.
incompatible elements, fractional crystallization 400
–, granulites 257f.
infrared spectra, sulfates 201
intergrowths, osumilite associations 126f.
interlayering, dunite and leucotroctolite 341
ion exchange between minerals and fluids, (Cl,F)/OH in apatites 291f.
isotopic equilibrium 24f.
– temperatures, O-isotopic fractionations, coexist. minerals of anorthosites 315

Jadeite 246
jotunite, Norway, O-isotope analysis 312

K, depletion in granulites 258
K-feldspar 124, 283, 388
kimberlite 181, 188, 205f., 230
– intrusion, velocities 211
–, origin 219ff.
– xenolith interactions 205ff.
– –, heat transfer 208
– –, mass transfer 208
– –, models 208
– –, transport rates 210
komatiites 168, 349, 411
Korjinski mosaic 283
K/Rb ratio, tonalites 257
K-richterite 191
kyanite 123, 319

Lamproites 191
lapilli tuffs 369f.
large ion lithophile elements, Israel basalts 401f.
lattice rotation, exsolved clinopyroxenes 106
lavas, Burin group 166f.
–, Lesbos 387f.
–, major element mixing models 13f.

–, Pinzon Isld. 369ff.
lawsonite 246f.
layering, troctolite 341f.
leptynites 283
leucite 191
leucogabbros, Cl and F in minerals 292f.
leuconorite 312f.
–, O-isotope data, Norway 313
leucotroctolite 340f.
lherzolite 230
–, equilibration temperature 205f.
light rare earth elements, basalts 157ff.
limestone 230
liquids temperature, kimberlite 221
long term incompatible elements 403
loparite 159

Macrospherulitic phenocrysts 339f.
madupite 191
mafic – ultramafic suites, chemical characterisation 168
magma evolution, ignimbrites 392
–, kimberlitic 220ff.
–, –, thermodynamics 220
–, –, water dissolution 220
–, troctolite, supercooling 345
–, –, supersaturation 339ff.
magnetite 13, 113, 124, 167, 230, 238, 245, 353, 372
mangerites 311
mantle, disequilibrium melting 157f.
– melting, model processes 165f.
–, Ni abundance 409
–, –, calculated element ratios 412
–, –, degrees of melting 411
– origin, anorthosites 312
– peridotite, partial melting 182f., 191
marbles 243
materials balance, granulite genesis 305
mélanges 43
melatroctolite 340f.
melt composition, granulite genesis 308
melting behaviour, basalts 158f.
–, metastable, granite system 73ff.
–, –, equilibrium 74
–, –, solidus temperatures 76
–, peridotitic mantle 220
mesoperthite 124, 135, 353ff.
–, Norway, O-isotope data 313
metamorphic belt, Turkey 243f.
metamorphic soles, Greece, sub-ophiolites 43f.
metamorphism, dependence of composition of perthite phases on thermal history 353f.
–, granitic suite, changes in bulk composition 271
–, granulite facies 257f.
–, greenschist facies 230
metapelites, O-isotopes 23f.
–, osumilite-bearing 124ff.
–, –, critical mineral assemblages 125
–, –, reactions 136f.
metasomatism, kimberlite-xenolith interactions 210f.
Mg-chlorite, stability 175f.
–, stoichiometry of reaction 176
Mg-distribution, minerals of metaigneous rocks 114
Mg-ilmenite 236
Mg-osumilite 139
microcline – low albite solvus 361f.
microstructure, perthites 353ff.
–, variation in dependence on metamorphic grade 357f.
mid-ocean ridge basalts 168
migmatites 73f.
mineral fractionations, O-isotopes 29f.
mixing of magmas 426
–, genesis of Maladeta plutonics 65f.
monazite 159
–, Glenfinnan gneiss, U-Pb data 90f.
mugearite 2f.
muscovite 335

Ni, abundance in mantle and primary melts 409
nordmarkite 81
norite 111, 312
noritomangerite 312

Oceanic crust 165
– dacite 372
– rhyolite 372
– tholeiite 374, 410
O-isotope data, Norwegian anorthosites and charnockites 313
– fractionations, alpine rocks 24f.
O-isotopic analysis, Maladeta, data 62
– –, procedures 59
– composition, Lepontine gneiss 21f.
olivine 4, 11, 183, 229, 230, 341, 372, 388, 420, 434
– gabbro 111, 340
–, garnet coronas 112f.
– tholeiites 369
ophiolites 43f., 165, 168, 243
ordering behaviour, reedmergnerite 329f.
orendite 191
orthogneiss 283
orthopyroxene 104, 124, 131f., 181f., 224, 232, 372, 388
–, garnet coronas 112f.
–, metapelites, AFM plots 133
–, O-isotope data 313
osumilite 124ff.
–, associations 126
–, compositions, AKF diagrams 129
–, intergrowths 128

Pahoehoe flows 369f.
parental magma of anorthosites 312
pargasite 46
partial equilibrium melting, alkali basalts 161
partial melting 14, 73, 219, 230, 397f.
–, garnet peridotite 158f., 165, 170, 182ff.
–, granulite genesis 303f.
–, model for granulite grade granitic suite 273
–, trace element behaviour 399
partition coefficients, crystal-liquid, REE in garnet 145ff.
–, –, samarium 147, 150
–, –, thulium 148
–, trace element fractionation models of Pinzon lavas 383
–, troctolite plagioclases 347f.
partitioning, Fe and Mg between coexist. Ti-clinohumite and olivine 237
–, Na-amphiboles and chlorites 248
Pb-isotopic analysis, Maladeta, data 60
–, procedures 59
pegmatites 89
pentlandite 230
peridotite 212, 219
–, phase relations 184
–, –, solidus and decarbonation reactions 184
peridotitic suite, inclusions in diamonds 181ff.
perovskite 231
perthites, microstructures 124, 135, 353ff.
–, equilibrium conditions 362
–, textural features 356f.
–, variation of abundance 355
phase relations, model peridotite 184
phengite, blueschists 247f.
–, composition 250
phenocrysts, Banks Penins. volcanics 4f.
–, Burin basalts 166f.
–, Lesbos shoshonites 388
–, pahoehoe lavas 369
–, troctolites 344f.
phlogopite 136, 191, 335
pigeonite 103, 372
pillow basalts 166f.
pipes, kimberlite 205f.
plagioclase 4, 46, 113f., 124, 135, 166, 266, 283, 313, 389, 432
– amphibole, cation exchange equilibria 33ff.
– amphibolites 46f.
– cumulate 372
– lherzolite, partial melting 170
–, melting experiments, granite system 76f.
–, –, compositions 78
–, phenocrysts, comb-layering 342
–, –, composition 344
–, –, morphology 339ff.
–, –, Pinzon Isld. lavas 369f.
–, –, troctolites 344f.
–, reactions, garnet formation 116
plastic deformation, influence on disorder kinetics 299
plate tectonics, Aegean area 387
plutonism, Variscan, Maladeta 58ff.
–, geodynamics 69
priderite 191
primary melts, mantle, Ni abundance 410
pulaskite 81
pumice 371
pumpellyite 167, 247
pyrite 167
pyrochlore 159
pyroclastic rocks 166, 387
pyrope, REE substitution 148ff.
pyroxenes 12, 101ff., 124ff.

Quartz 4, 33, 114, 124f., 132, 166, 192, 247, 268, 283, 353
–, Lepontine gneiss, O-isotopes 21f.
– mangerites 311
– nordmarkite 81
quartzite 124

Radioactive decay 93
Raman spectra, sulfates 201
rare earth element distribution patterns, basalts 157ff., 165f.
– partition, sphene/apatite 81f.
rare earth elements, concentrations in minerals of the Kangerdlugssuaq intrusion 82f.
–, differentiation series, Israel 412
–, lavas, Pinzon Isld. 383
–, shoshonites, Lesbos 389f.
Rayleigh law, validity, differentiation series 407
Rb, depletion in granulites 258
Rb/Sr geochronology, Glenfinnan gneiss 88ff.
–, Maladeta plutonics 60f.
reactions, chlorite + dolomite = spinel + forsterite + calcite + CO_2 + H_2O 175f.
–, clinohumite formation 232
–, garnet formation 116f.
reedmergnerite 329f.
–, cell parameters 330
regional metamorphism 43f., 124f., 230f., 243f., 257f., 271f., 353f.
retrograde metamorphism 232
retrogression, granulite grade granitic suite 271
rhyolite 4f., 165, 370f., 387
rutile 124, 283

Sanidine 4
sapphirine – quartz coexistence 124ff., 130f.
Schreinemakers analysis, Enderby granulites 138f.
sea-cliff sections, Pinzon volcanoe 369
sericite 166
serpentine 232
serpentinite 44, 229f.
shoshonitic suite, Lesbos, geochemistry 387ff.
silicate liquids, immiscible 319f.
–, viscosity 324
silicon mobility, garnet formation 115ff.
sillimanite 124f., 319
skeletal plagioclase crystals 339f., 344
Sm, partition between garnet and liquid 147f.
snowflake plagioclase 339ff.
sodic amphibole 246
sodic pyroxenes, blueschists 246f.
–, composition 250
solid solutions, orthopyroxenes 132
–, sapphirine 131
–, spinels 137
solidus temperatures, granite system 76
spessartine 247
sphene 46, 159, 244, 335, 388
– /apatite, REE partition 81f.
spherulites, plagioclase in troctolite 340f.
spinel 113f., 124, 135, 175, 373, 431
– lherzolite 212
spreading rate, influence on basalt composition 429f.
staurolite 29
stratovolcanoes, Lesbos 387
subduction zone 58
sub-ophiolite metamorphic rocks, Greece 43ff.
substitution, REE in garnets 146f.
sulfate in travertine 197f.
– minerals, Raman and i.r. spectra 201
supercooling, melts 75, 345
supersaturation, magma 339ff.
– textures 345f.
syenite 2
symplectite 112, 118, 124
systems, CaO-MgO-SiO_2-CO_2, high-pressure liquidus phase fields 184
–, SiO_2-MgO-CaO-FeO-TiO_2-Al_2O_3 319ff.
–, –, cation distribution coefficients 322
–, –, immiscible silicate melt pairs, analysis 321

Talc 229, 247
tephra 369f.
thenardite, Raman and i.r. spectra 201
thermal history, metamorphism, influence on perthite microstructure 353f., 361
– solutions, sulfate content 199
– stability, Ti-clinohumite 416f.
thermodynamics, amphibole – plagioclase cation exchange equilibrium 33
–, Ti-clinohumite 420f.
tholeiites 168, 369, 372, 398
Ti-chondrodite 420
Ti-clinohumite, stability 229ff., 415ff.
–, thermodynamics 420f.
TiO_2, amphibolite and granulite grade rocks, New Quebec 306
–, partitioning in immiscible silicate melts 326
titanaugite 166
titanomagnetite 4f., 372
Tm, partition between pyrope and liquid 148
tonalite 232, 257, 266f.
–, derivation by fractional crystallization 277
tonalitic gneiss 266
tourmaline 245
trace element evolution, Israel basalts 397ff.
–, behaviour during partial melting and fractional crystallization 399
trace elements, Banks Penins. volcanics 7f.
–, Pinzon lavas 376ff.
–, –, abundance 384
–, –, fractionation models 382
–, –, partition coefficients 383
trachyte 2
transport rates, kimberlite-xenolith interactions 210
travertine, sulfate substitution 197f.
tremolite 33, 229
tridymite 5
troctolite 339ff.
trondhjemite 257, 266f.
–, derivation by fractional crystallization 277
tuff 166, 369f.
two-mica granites 58f.

U-Pb zircon systems, gneiss, data 91
–, multiepisodic changes 93
ultrabasic rocks 230
ultramafic belt, Turkey 243f.
– rocks 43
– xenoliths from kimberlites 205ff.
– –, *P-T* estimation 206
upper mantle 15, 181f., 205, 219
–, garnet stability 212
–, nature beneath N-Lesotho 214
–, *P-T* correlation beneath Sibirian platform 225
–, wadeite stability 191f.

Variscan plutonism 57f.
veins 231f.
vermiculite, fission tracks 335
volatiles, troctolite magma 346
volcanic cycles, Pinzon Island 371f.
– features, Pinzon Isld. 369f.
– rocks, Banks Peninsula 1ff.
– –, recent spreading ridges 425ff.
– –, –, compositional changes in dependance on spreading rate 429
– sequence, Lesbos 387f.
volcanoes, Banks Peninsula 1ff.
–, Galapagos Archipelago 367ff.

Wadeite stability 191f.
–, experimental results 192
–, X-ray powder data 192
water, dissolution in silicate melts 220
–, effect on Al/Si disorder kinetics in feldspars 297f.
–, role in alpine metamorphism 20ff.
websterites 212
wolgidite 193
wyomingite 191

Xenoliths 181
–, gabbroic in Pinzon lavas 380
–, in kimberlites 205ff., 415
–, –, equilibration temperatures 205f.
–, in shoshonites, Lesbos 388

Zircons 159, 192, 372
–, gneiss, U-Pb data 87ff.
–, orthogneiss, U-Pb data 285
zoisite 167
zone refining, mantle melting 165
zoning, blueschist amphiboles and pyroxenes 250